Alberta
ENVIRONMENT

WESTERN AND NORTHERN CANADA ACID DEPOSITION RT AP ACTIVITIES

ANNUAL REPORT 1989

A report on monitoring and research studies related to acid rain and long range transport of atmospheric pollutants in Western and Northern Canada

BC

Environment and Public Safety

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WESTERN AND NORTHERN CANADA ACID DEPOSITION/LRTAP ACTIVITIES

ANNUAL REPORT 1989

A report on monitoring and research studies related to acid rain and long-range transport of atmospheric pollutants in Western Canada and Northern Canada

Prepared by the
Technical Committee for the
Long-Range Transport of Atmospheric
Pollutants in Western and Northern Canada

August 1990

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MAP OF WESTERN CANADA

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1. INTRODUCTION

HISTORY

The Governments of British Columbia, Alberta, Saskatchewan, Manitoba and Canada have recognized the potential for harm from acid deposition in some parts of western Canada. A commitment was made in Edmonton on September 4, 1980 by the deputy ministers of the four western provinces and senior officials from Environment Canada to cooperate on issues related to the Long Range Transport of Air Pollutants (LRTAP). A Consultative Committee of deputy ministers and a Technical Committee of senior officials were established at that time to coordinate monitoring, research, and other activities. In 1982, the Government of the Northwest Territories joined these committees and a three year program was launched to identify current conditions in western and northern Canada and to provide information for developing management strategies. In March 1984, a second three year agreement was signed in recognition of the continued cooperative efforts towards a better understanding of the LRTAP issue in western and northern Canada. In 1988, a third three year agreement ending March 1991, was signed to reaffirm the commitment of the mentioned governments towards coordinated research and monitoring activities related to LRTAP.

Current Status

Currently soils and geology and surface water sensitivity maps for western and northern Canada have been prepared. A framework for developing interim target loadings based on literature from around the world was suggested. Monitoring continued at the provincial and federal levels, emission inventories were kept and mathematical models to describe the phenomena of transport, transformation and deposition of airborne pollutants in the medium range (10 to 500 kilometres) were addressed.

Future Activities

The major research thrusts up to March 1991 are listed below. These are identified in detail in the document signed in April 1988*.

1. Determination of the sensitivity of western and northern Canadian environment to acidic deposition.

2. Establishment of scientifically validated target loadings to protect highly and moderately sensitive aquatic and soil systems in western and northern Canada.

3. Continuation of monitoring activities with particular attention to:

   a. sulphate and nitrate deposition rate in precipitation;
   b. characterization of total deposition (wet versus dry);
   c. quality of sensitive surface waters and terrestrial environments especially where data gaps exist;
   d. characterization of the role of nitrate, ammonia, and metals deposition in the western and northern Canadian environment.

4. Validation of mathematical models to assist in management strategies.

A summary of the monitoring and research activities related to acid deposition and LRTAP carried out in western and northern Canada during 1989 follows.

* Western and Northern Canada Long Range Transport of Atmospheric Pollutants-Objectives and Three Year Program: 1988-1991, by Western and Northern Canada LRTAP Technical Committee, April 1988.

2. BRITISH COLUMBIA

2.1 EMISSIONS AND CONTROL TECHNOLOGY

Sulphur Emissions in a Coastal Area

The data presented in the report on sources of sulphur emission on Vancouver Island and in the south coastal area of the Province mentioned in the Annual Report 1987 have now been analyzed. Based on this analysis, a draft in-house report was prepared jointly with the Ministry of Energy, Mines and Petroleum Resources, titled, "The Vancouver Island Natural Gas Pipeline: A Solution to Acid Rain in Southwestern British Columbia?". The report discussed the effectiveness of potential reduction in sulphur emissions if the existing pulp and paper mills' power boilers and recovery boilers burning high-sulphur oil were switched to either low-sulphur oil or natural gas.

Inventory of Emissions

Joint work involving the Ministry of Environment and Environment Canada is complete. A description of this work is in Section 8.

Report: See Section 8

2.2 AIR QUALITY AND DEPOSITION

Precipitation Chemistry Stations

The province of British Columbia continued weekly monitoring of precipitation with automatic collectors at Cranbrook, Kamloops, Kelowna, Kitimat, Nanoose, Port Hardy, Pender Island, East Richmond, Seymour Dam, Smithers, Spectacle Lake, Squamish, Vancouver (airport), and Victoria. At present, the network is being re-evaluated for the suitability of sites and the mechanical reliability of the collectors. This is to ensure that the precipitation chemistry samples are representative of the area.

These monitoring stations provide weekly precipitation chemistry data which include sulphate deposition. From the sulphate deposition values, the annual rate of sulphate deposition is calculated. The excess sulphate values for 1988, expressed in kilograms of sulphate per hectare per year (kg SO_4/ha/y) are: Cranbrook 6.7, Kamloops 1.7, Kelowna 2.0, Kitimat 13.4, Nanoose 6.3, Port Hardy 14.7, Pender Island 6.4, East Richmond 16.2, Seymour Dam 30.5, Smithers 2.3, Squamish 23.1, Spectacle Lake 4.9, Vancouver 14.9 and Victoria 19.6.

A detailed 1987 British Columbia Precipitation Chemistry data summary and statistical analysis has been completed. A report has been written and is being reviewed for publication.

Report: (a) The annual acid precipitation monitoring reports for 1984, 1985, 1986, 1987 and 1988.

(b) 1987 British Columbia precipitation chemistry data summary and analysis are available from the Environmental Protection Division, Ministry of Environment, British Columbia.

2.3 SURFACE WATERS

pH Tolerance of Aquatic Plants of British Columbia

The study of the pH tolerance of aquatic plants of British Columbia is being conducted in three parts. Part 1 was a literature review of the pH limits of aquatic plants of the world. Part 2 involved analysis of existing environmental data relative to the presence of species of aquatic plants in British Columbia. Part 3 will involve experimental work to determine pH limits for some common aquatic plants for British Columbia.

Report: Reports on Part 1 and 2 data are available from the Water Management Branch, Ministry of Environment, British Columbia.

Lake Trend Monitoring

Monitoring is being conducted to determine whether acidic inputs are causing a significant deterioration of water quality. Water samples are collected monthly at six sensitive lakes in the south-western part of the province: Vancouver Island, Saltspring Island and Lower Mainland. Analysis of these samples includes pH, alkalinity, acidity, general ions and metals.

Also, phytoplankton and zooplankton are collected monthly from May through October. The planktonic organisms are identified, and chlorophyll-a is measured.

Maps of the distribution of aquatic plants (aquatic macrophytes) are made on the basis of surveys taken every five years. The program began in 1984 and data are to be analyzed in a report to be prepared in 1990.

Report: Data are available from the Water Management Branch, Ministry of Environment, British Columbia.

Water Quality Criteria

Water quality criteria have been developed for aluminum and are being developed for pH.

Report: Reports are available from the Water Management Branch, Ministry of Environment, British Columbia.

Lake Sensitivity Mapping

Lake sensitivity maps for British Columbia have been prepared.

Report: Maps are available from the Water Management Branch, Ministry of Environment, British Columbia.

2.4 SOILS AND GEOLOGY

No activities.

2.5 VEGETATION

Impact of Atmospheric Pollutants on Vegetation

The Ministry monitors the health of vegetation in various parts of the province where plants are exposed to oxides of sulphur, fluoride, acid rain and heavy metals.

The Ministry continually reviews scientific literature on atmospheric pollutants and their effects on forest and other ecosystems.

Reports of environmental base data essential for the effective monitoring and evaluation of environmental impacts from ongoing and proposed activities are under compilation, including data for Prince George, Jarvis Creek-Morkhill River, and Vancouver Island. Potential impacts on the vegetation resources of the interior of British Columbia from proposed power generation facilities have been evaluated, and preliminary guidelines for impact assessment are under development. Similarly the potential effects of a roaster's emissions on the vegetation of northern alpine areas were investigated and monitoring studies proposed. The causes of death of trees along a railway in the interior of British Columbia were studied.

In cooperation with the Ministry of Forests and the Ministry of Transportation and Highways, the Ministry is investigating the causes of damage to roadside trees. In cooperation with the Ministry of Parks and the University of Victoria, the Ministry is investigating the sensitivity of lichens from northern British Columbia and techniques for "early detection" of damage from sulphur dioxide. The recovery of damaged vegetation in the near alpine of the Cascade Mountains was monitored.

Internationally, the Ministry, Western Conifers Cooperative of the Environmental Protection Agency (USA), British Columbia Ministry of Forests and Forestry Canada are collaborating to estimate the impacts of atmospheric pollutants in the Puget Sound Basin. A pilot study, using remote sensing and dendrochronological techniques aims to determine the impacts from sulphur dioxide on vegetation on northern Vancouver Island.

A pilot study of the effects of oxidants on the forest nursery seedlings in the Lower Mainland is in progress.

Conifer foliage and vegetation tissues are being sampled and analyzed for a range of chemical components, and will provide an understanding of the variation in natural concentrations of these, and the range in concentrations under influence of atmospheric exposures to pollutants.

2.6 HEALTH

No activities.

3. ALBERTA

3.1 EMISSIONS AND CONTROL TECHNOLOGY

Sources and Emissions Inventories

A contractor was retained to prepare the 1987 inventory of nitrogen oxides emissions.

3.2 AIR QUALITY AND DEPOSITION

Passive Monitoring of Ambient Sulphur Dioxide

A passive sampler was developed to monitor SO_2 in remote locations. The sampler has the same physical dimensions as Huey plates, which are currently used by Alberta Environment. This will allow them to be substituted in existing sample holders. Advantages of the new device, which consists of K_2CO_3/Glycerol absorbent and a diffusion barrier, are linearity to ambient concentration over a wide range of meteorological conditions and non-interference from H_2S. Ambient samples can be analyzed by Ion Chromatography (Dionex 2020i; AS4A column; continuous suppression) without interference. The sample is useful in that, it will enable lower levels of SO_2 such as those encountered in baseline sites to be determined more accurately.

The method has been tested successfully in the field, compared with an equivalent method (PbO_2 method) and will be adopted in the summer of 1990 for measuring SO_2.

Report: Bertram, H., Christensen, B., Hannak, B. and Das, N. 1988. Developments in Passive Monitoring of Ambient Sulphur Dioxide. Paper presented at CPANS-APCA, May 15-17, 1988, Calgary. Air Analysis and Research Branch, Chemistry Division, Alberta Environmental Centre, Vegreville.

Measurement of Dry Deposition

The K_2CO_3 passive sampler measures the concentration of SO_2 accurately and this can be used to estimate dry deposition. A similar passive sampler using triethanol amine (TEA) have also been tried to measure the concentration of NO_2. Multiplying the concentrations of SO_2 and NO_2 by the known "deposition velocities" for SO_2 and NO_2 will give the dry deposition of these gases.

Report: Results will be available from the Air Analysis and Research Branch, Chemistry Division, Alberta Environmental Centre, Vegreville.

Analysis of Precipitation Chemistry Measurements in Alberta

Alberta Environment commenced monitoring precipitation on a monthly basis in 1978 with six stations. Currently the network consists of thirteen stations. As well, daily precipitation samples are collected at one site. The chemical composition is monitored to detect significant changes resulting from industrialization within the province and provide an historical data base. Alberta precipitation has an average pH of 5.5, little different from the theoretical background value of 5.6. The calcium cation and sulphate anion are the most dominant species in precipitation, and more so in southern Alberta than in the northern part of the province. The highest hydrogen ion concentrations occur in the summer months, while the concentrations of most ions have their largest values in winter.

The average wet sulphate deposition in Alberta is approximately 10 kilograms sulphate per hectare per year; lower than the eastern Canada target loading of 20 kilograms sulphate per hectare per year. In Alberta, unlike eastern Canada, the wet sulphate is not a direct measure of acid deposition because a large fraction of sulphate is not associated with the hydrogen ion. Corrections for sulphate associated with calcium and the relative importance of dry to wet deposition must be considered when comparing to a target loading.

Report: For further information, contact the Environmental Quality Monitoring Branch, Environmental Assessment Division, Alberta Environment.

3.3 SURFACE WATERS

Lake Monitoring Network

The objective of this project is to establish long-term data bases which can be used to identify changes in either the trophic state or acidification status of a lake. Long-term monitoring has been initiated in four lakes in central Alberta (Wabamun, Nakamun, Baptiste, Ethel) which have been sampled at monthly intervals since 1983. Two poorly buffered, unnamed lakes on the Muskeg Mountain Upland have been sampled monthly since May 1988. Legend Lake, on the Birch Mountains Upland has been sampled since May 1989.

Report: Data are available from the Environmental Quality Monitoring Branch, Environmental Assessment Division, Alberta Environment.

3.4 SOIL AND GEOLOGY

Long-Term Measurement of the Acidification of Non-Cultivated Soils in Alberta

Eight monitoring sites have been established to measure the acidification of soils over a long period of time in areas where deposition of industrial acid precursors is expected to occur. The monitoring sites are intended to measure the worst situations, and act as soil acidification early warning sites.

The sites are sampled every four years, two of the eight sites are sampled annually. Analytical data from two samplings from each site have been compiled and assessed for impact. No previous acidification trends are evident from the first eight years of monitoring.

Report: A draft report has been prepared; the final version is expected to be available for distribution.

3.5 VEGETATION

No activities.

3.6 HEALTH

Health Effects of Sulphur Gases

The 359 m^2 inhalation toxicology research facility at the Alberta Environmental Centre in Vegreville was designed on the containment principle. The 14 air handling systems ensure that each room is either positive or negative relative to the adjacent room to provide four levels of containment. Two 48 m^2 inhalation laboratories allow simultaneous operation of a maximum of twelve 2 m^3 inhalation exposure chambers or their equivalent. There are three 2.6 m^2 service laboratories for chemical toxicology and tissue culture, the latter providing alternative methods for toxicological investigations. Monitoring and safety equipment has been installed for studies of the acute and sub-chronic toxicity of hydrogen sulphide. Staff are trained in safety drills. Some operations are monitored by computer.

There are ten whole body inhalation chambers:

Size (L)	Quantity	Use
2000	5	long term studies
118	1	allows rapid introduction of animal in/out of atmosphere
69	4	short term studies

In addition, there are two 36-port nose-only chambers, and one single animal head-only chamber.

Inhalation toxicological research at the Alberta Environmental Centre is multidisciplinary. That is, each project includes several or all of the disciplines such as pathology, electron microscopy, haematology, clinical pathology, biochemistry, cell culture, analytical chemistry, statistics, mechanical engineering and chemical engineering. Safety is a component of each project.

Research on the Health Effects on Sulphur Gases is Ongoing

Over twenty experimental studies have been completed on hydrogen sulphide. In addition, studies have also been conducted with sulphur hexafluoride, obscurant smoke and acetone. The duration of experimental exposure of laboratory rats to hydrogen sulphide has ranged from one minute to six hours for a single exposure, and up to eight hours/day for one to five weeks for serial exposures. Exposure concentrations have ranged from 2.1 (1.5) to 2811 (2008) mg m^{-3} (ppm).

The primary findings in hydrogen sulphide acute toxicity are:

(a) reversible necrosis of respiratory epithelium;
(b) irreversible necrosis of olfactory epithelium;
(c) massive pulmonary oedema;
(d) transient and reversible alveolitis;
(e) no observable lesions in non-respiratory organs or tissues;
(f) no detectable haematologic alterations;
(g) inhibition of cytochrome oxidase.

An investigation is in progress to determine leakage sites for the massive pulmonary oedema seen after exposure to lethal or near-lethal concentrations of hydrogen sulphide. A collaborative study is underway on the role of neurotransmitters in lung injury due to hydrogen sulphide. Future investigations include study of the effects on reproduction and productivity.

There are 40 publications related to this research.

Report: For further information on this research, contact the Animal Sciences Division of the Alberta Environmental Centre, Vegreville, Alberta.

4. SASKATCHEWAN

4.1 EMISSIONS AND CONTROL TECHNOLOGY

Saskatchewan Air Emissions Inventory of Sulphur Dioxide and Nitrogen Oxides

The inventory of sulphur dioxide and nitrogen oxides emissions is being updated for 1987. The inventory will be prepared according to the methods outlined in the emissions inventory methods manual developed by the Western Canada LRTAP Inventory Technical Working Group.

Report: A final report will be available next year from the Air and Land Protection Branch, Saskatchewan Environment and Public Safety.

4.2 AIR QUALITY AND DEPOSITION

Poplar River Thermal Power Plant Ambient Air Monitoring Program.

Saskatchewan Environment monitors sulphur dioxide and suspended particulate at one location, Coronach. Few detectable concentrations have been recorded at this site. The highest hourly SO_2 concentration recorded in 1989 was 0.112 ppm, well below the provincial standard. The average suspended particulate concentrations exceeded the provincial standards only once during 1989 at a level of 152.9 $\mu g/m^3$/24 hours.

Report: Data summaries are available from the Air and Land Protection Branch, Saskatchewan Environment and Public Safety.

4.3 SURFACE WATERS

Surface Water Sampling in Northern Saskatchewan

Approximately 60 surface water stations in northern Saskatchewan are monitored. Most of the samples are collected by industry at the request of Saskatchewan Environment and Public Safety.

Report: Data summaries are available from the Mines Pollution Control Branch, Saskatchewan Environment and Public Safety.

4.4 SOILS AND GEOLOGY

No activities.

4.5 VEGETATION

No activities.

4.6 HEALTH

No activities.

5 MANITOBA

5.1 EMISSIONS AND CONTROL TECHNOLOGY

Emission Inventory

The inventories for nitrogen dioxide and sulphur dioxide are being maintained by the province.

Report: Data summaries and/or reports are available from Manitoba Environment.

5.2 AIR QUALITY AND DEPOSITION

Air Quality Monitoring in Northern Manitoba

Ambient air quality monitoring for sulphur dioxide and particulate matter including heavy metals was undertaken at one site within the vicinity of the Hudson Bay Mining and Smelting non-ferrous smelter in Flin Flon. Levels above air quality objectives/guidelines were recorded (at a frequency somewhat higher than in previous years). As an interim measure, prior to major emission reductions required by regulation under The Manitoba Environment Act by the year 1994, Hudson Bay Mining and Smelting has implemented operational controls and has undertaken a public warning program.

Report: Data summaries and/or reports for previous years of monitoring activities are available from Manitoba Environment.

Precipitation Monitoring

Activities during 1989 were focused towards the design and re-establishment of a CAPMoN-like four site daily precipitation quality monitoring network. Monitoring is scheduled to restart in 1990.

Report: Data summaries and/or reports for previous years of monitoring activities are available from Manitoba Environment.

Snowpack Survey

Snow pack monitoring was carried out in March 1989 to determine wet and dry deposition of selected ionic species over the four month wintertime period. The survey included 22 stations (7 within the local deposition range of the Inco smelter at Thompson, 7 within the local deposition range of the Hudson Bay Mining and Smelting at Flin Flon and 8 throughout the province). Samples were analyzed for pH, conductance, acidity, sulphate, nitrate, chloride, calcium, ammonium, magnesium, sodium and potassium. The pH readings at all the 8 locations were above 5.6. The pH of snow at northern sites ranged from 6.45 to 7.96. Wet and dry deposition of sulphate ranged from 0.42 to 1.19 kg/ha. The annual deposition estimated from this data would be in the range of 1.26 to 3.57 kg/ha, well below the objective of 20 kg/ha which is used in Eastern Canada as a guideline to protect sensitive lakes. Nitrate deposition ranged from 0.09 to 0.29 kg/ha. Deposition of calcium to the snow was higher than in 1988 ranging from 0.17 to 2.12 kg/ha. Since calcium buffers the pH, this could have a modified acidifying effect on precipitation.

Windblown soil in southern Manitoba resulted in increased deposition of sulphate, nitrate and calcium relative to northern locations. The pH at southern sites were in the 5.73 to 6.64 range, with 2 of 5 sites greater than 6.0.

Report: Data summaries and/or reports are available from Manitoba Environment.

5.3 SURFACE WATERS

Surface Water Sampling

No specific water quality sampling related LRTAP was carried out during 1989. A report on aquatic sensitivity to acid deposition in Manitoba was released in December.

Report: Reports and/or data summaries of past data are available through Manitoba Environment.

5.4 SOILS AND GEOLOGY

No activities.

Report: A report on Manitoba Terrestrial Sensitivity to Acidic Inputs is available through Manitoba Environment

5.5 VEGETATION

Vegetation Studies Around Northern Smelters

Studies of coniferous regeneration response to heavy metal contaminated soil in the vicinity of mining and smelting complexes at Thompson continue. A report on the effects determined near the Inco smelter at Thompson has been released. A report on the effects determined near the Hudson Bay Mining and Smelting complex at Flin Flon is in preparation. These greenhouse studies have indicated that metal contaminated soils are inhibiting growth of Black Spruce and Jack Pine seedlings. There is concern that natural regeneration may not be successful at sites close to the smelters where heavy metals have accumulated in the soil.

Report: Reports are available from Manitoba Environment.

Tree Generation Study Near Thompson

Field studies of Black Spruce and Jack Pine seedling plots near the Inco smelter at Thompson continue. This study is a follow-up of greenhouse studies. The objective is to determine the effects of heavy metal contaminated soil on planted seedlings.

There are also plans to assess the effects of heavy metal contaminated soils on the regeneration of Repap cutovers if harvesting occurs within 10 km of the smelter.

Report: These studies are ongoing. Interim results are available from Manitoba Environment.

Terrestrial Monitoring

Eight forest monitoring sites are being routinely monitored in areas sensitive to acidic deposition throughout the province. This program is being carried out in cooperation with Forestry Canada's ARNEWS program.

Report: Baseline data have been collected and data summaries are available from Manitoba Environment.

5.6 HEALTH

Cadmium in Wildlife

The program of analyzing cadmium in kidney and liver of moose, deer, elk, wolf, coyote and bear is continuing. The health warning to hunters not to consume kidney of wildlife and to limit the consumption of liver still continued in 1989.

Report: A report is available from Manitoba Environment.

6. NORTHWEST TERRITORIES

6.1 EMISSIONS AND CONTROL TECHNOLOGY

No activities.

6.2 AIR QUALITY AND DEPOSITION

Aerosol Deposition

The Northwest Territories is supporting a study of aerosol deposition in snow cores, lake bottom sediment, and glacial ice in the central arctic. The study is being undertaken by Mr. Dennis Gregor, Inland Waters Directorate, Regina, Saskatchewan.

Report: Further information is available from the Inland Waters Directorate, Regina, Saskatchewan.

Precipitation Chemistry

The Snare Rapids CAPMoN station continues operation.

6.3 SURFACE WATERS

No activities.

6.4 SOIL AND GEOLOGY

No activities.

6.5 VEGETATION

No activities.

6.6 HEALTH

Wildlife Studies

Concern over contaminants from long range transport sources entering the food chain has resulted in a number of wildlife studies being undertaken.

The Government of the NWT, Department of Renewable Resources, participated in a number of studies on contaminants in wildlife.

These have included cesium 137 sampling in caribou and wolves, toxaphene in MacKenzie River fish and organochlorine in polar bears and in peregrine and gyrfalcon, geese and ptarmigan.

Report: Further information is available from the Wildlife Service Department of Renewable Resources (Yellowknife) and the Canadian Wildlife Service (Edmonton).

Blood Samples - Native Population

The study of polychlorinated biphenyl (PCB) concentrations in the native people of Broughton Island was completed. This study conducted by the federal department of Health and Welfare, Indian and Northern Affairs and Fisheries and Oceans, was based on the analysis of PCB concentrations in breast milk and blood, and in the diet of the people.

Health and Welfare also measured radiation levels in residents of Baker Lake and Fort Rae.

Report: Further information is available from Health and Welfare Canada (Ottawa).

The Northwest Territories Department of Health has created a Contaminants Unit to study risk from contaminants to environmental health.

7.1 EMISSIONS AND CONTROL TECHNOLOGY

No activities reported for 1989.

7.2 AIR QUALITY AND DEPOSITION

Canadian Air and Precipitation Monitoring Network (CAPMoN)

CAPMoN is the national network for air and precipitation monitoring, with stringent siting criteria and sampling protocols such that each station is considered representative of rural and remote locations in Canada. Precipitation samplers used by this network open only during precipitation events. Daily precipitation samples are analyzed for: pH, sulphate, nitrate, chloride, ammonium, potassium, sodium, magnesium, and calcium. Air samplers sample on a daily basis using filter packs. Samples are analyzed for particulate, sulphate, nitrate, ammonium, potassium, sodium, gaseous nitric acid, and sulphur dioxide.

The western Canada portion of this network operating in 1989 consisted of the following:

Manitoba	McCreary
	Island Lake
Saskatchewan	Cree Lake
Alberta	Esther
Northwest Territories	Snare Rapids
British Columbia	Saturna Island

The stations at Esther, Snare Rapids and Saturna Island do not have air sampling equipment.

The Saturna Island site became operational on June 1, 1989. The B. C. Ministry of Environment has co-located a precipitation chemistry sampler for data intercomparisons. An open house was held in September 1989 which allowed residents to tour the site and ask questions about the program.

Report: Data summaries of precipitation chemistry are published annually, and are available from: Atmospheric Environment Service, Downsview, Ontario.

Hydrometeorology of the CANSAP Sampler

To determine the evaporative loss and under-catch of the CANSAP sampler, CANSAP and CAPMoN samplers were installed at the Regina Airport. Samples were weighed daily, and a comparison of the sample weights was made. Sampling was completed in 1987, and focused solely on evaporative losses. Preliminary results indicate significant daily evaporative losses from the CANSAP sampler, but greatly reduced evaporative losses have been achieved with the improved design of the CAPMoN sampler. A final report on the project is expected to be completed in 1990.

Report: Information is available from: Atmospheric Environment Service, Regina, Saskatchewan.

British Columbia Transboundary Precipitation Chemistry

Further work on the event precipitation chemistry data gathered in southern British Columbia was completed. The Statistics Department of the University of British Columbia have agreed to analyze the event precipitation chemistry data. Data from before and after the ASARCO smelter closure will be considered to determine the statistical significance of identified trends. A study is also proposed to consider combining the data with that gathered in Washington State in order to complete the analysis of the impacts associated with the closure of the smelter.

Progress on the statistical analysis by the University of B. C. has been temporarily halted due to the lack of support staff.

Report: Information is available from Pacific Region, Atmospheric Environment Service, Vancouver, British Columbia.

Western Canada Deposition Modelling (Statistical LRTAP Models)

Three LRTAP statistical models have been implemented and tested over the Prairies. A preliminary report to the WNCLTC provided a summary of the three models and described preliminary results from application to the prairie provinces.

Report: Information is available from Pacific Region, Atmospheric Environment Service, Vancouver, British Columbia.

7.3 SURFACE WATERS

Water Chemistry Sampling

Environment Canada monitors a large number of surface water sites in the Prairie Provinces and Northwest Territories on a monthly basis, or (primarily in the NWT) on a time-of-visit basis. This monitoring is conducted as part of the Water Quality Branch program, or as a result of agreements with the provincial government or agencies. Periods of record average ten or more years, and are useful for assessing LRTAP effects.

Report: Information is available from: Inland Waters/Lands, Environment Canada, both in Regina, Saskatchewan and Yellowknife, Northwest Territories.

Water Quality Sampling - Wood Buffalo National Park

A monthly sampling program was initiated in August 1989 with Inland Waters for monitoring of inflowing baseline water quality at two stations: a) Peace Point on the Peace River; and, b) at the 28th Base line where the Athabasca River enters Wood Buffalo National Park. This project is to be on-going in 1990/91.

Report: Technical and Park-related information is available from: Inland Waters, Water Quality Branch, Environment Canada, Calgary, Alberta; G. Mercer, Wood Buffalo National Park.

Slave River Basin Monitoring

A water quality monitoring program has been developed for the Slave River by Parks Canada/GNWT/DIAND and EP/EC.

Reports: Further information is available from: Environment Canada, Environmental Protection, Yellowknife, NWT.

Water Quality - Nahanni National Park

The Canadian Parks Service and Inland Waters are participating in a water quality study of several streams tributary to the South Nahanni River in Nahanni National Park to determine baseline conditions prior to establishing water quality objectives. Two years of field data have been collected and a project write-up is presently in progress.

Reports: Further information is available from: Environment Canada, Environmental Protection, Yellowknife or Chief Park Warden, Nahanni National Park, Fort Simpson, NWT.

Ellesmere Island National Park Research Permit

The Department of Fisheries and Oceans (DFO) has applied for a research permit to conduct water quality, sediment, flora, fauna and other applied studies at Lake Hazen, Ellesmere Island National Park. One of the main aspects of this work is to be directed towards LRTAP.

Report: Information is available from Freshwater Institute, Winnipeg, Manitoba.

History and Current Fluxes of Atmospheric Pollutants to Remote Lakes in the Temperate Boreal and Arctic Regions of Canada.

In collaboration with other DFO and Environemnt Canada laboratories, Freshwater Institute staff have begun a research program to determine the history of deposition and current rates of supply of atmospheric pollutants to small remote lakes in a north-south transect from Western Ontario to the high Arctic. We also are trying to determine the relationship between these rates of supply of atmospheric pollutants and selected pollutant-stress enzyme systems in fish in these same lakes. We are also testing hypotheses concerning the possible concentrations of volatile organic and metal pollutants in the Arctic, via the "cold finger effect", and the possibility that some of these atmospheric pollutants in high Arctic lakes are from air masses derived from the USSR, northern Asia, and northern Europe.

We have designed, constructed and field tested a new sediment sampling tool, called a box corer, to obtain large samples of sediment. We can slice thin layers of lake sediment for the measurement of PCB, DDT, PAH, and many other organic pollutants, and lead, mercury and cadmium. These sediment layers can be dated, using the radioactive decay of natural Pb-210, in order to describe the history of deposition of these pollutants. Pb-210 measurements also allow the flux, or rate of supply ($\mu g/m^2 \cdot yr$) of each pollutant at the sediment surface to be calculated.

We hope to relate this pollutant rate of supply to the activity of enzyme systems that are known to respond to pollutant stresses. Mixed function oxidase enzyme activity is thought to increase in response to exposure to certain organic pollutants, and this increased enzyme activity probably decreases fish growth and reproduction.

We are currently analyzing box cores from the Experimental Lakes Area (ELA) in Western Ontario, and Saqvaqjuac (SAQ) on the West Coast of Hudson Bay. Cores were be obtained from Cornwallis Island lakes in June 1989. Atmospheric pollutant fluxes to ELA lake sediments are similar or slightly lower than in nearby Lake Superior. Deposition of PAHs (derived from coal and oil combustion) began at ELA around 1900, and peaked in the late 1950s and early 1960s. DDT, PCB and other organochlorine pollutants appeared in the ELA sediments around the late 1940s, and increased to the surface sediments. The variability of lake trout MFO enzyme system activity is currently being studied. Similar measurements on the Arctic lake sediment cores at SAQ and Cornwallis Island reveal that pollutant supply rates are lower, but they appear in the sediments with a similar history of deposition.

The results of this work are intended to be related to similar measurements in other parts of Canada, USA, Europe, and perhaps some of the under-developed countries, where many of the organic pollutants have their origin.

Report: Information may be obtained from: Fisheries and Habitat Management Freshwater Institute, Winnipeg, Manitoba.

Biological Exposure Indicators for Metals Discharged by a Smelter

Eight lakes, four in Manitoba and four in Saskatchewan, were selected to evaluate effects on fish, crayfish, and zooplankton of atmospheric deposition of metals discharged by the smelter in Flin Flon, Manitoba. Lakes in Manitoba ranged from 10 to 31 km away from the smelter, and in Saskatchewan, lakes were from 6 to 26 km away from the stack. Lakes ranged from 40 to 677 hectares in surface area, and from 3.0 to 24.4 metres in maximum depth. Water chemistry parameters demonstrate wind-distance and wind-direction dependencies in sulphate deposition. These lakes, however, are not acidified (pH values range from 7.4 to 8.3).

Four sediment cores, obtained by SCUBA diving were removed from the deepest portion of each lake. Cores were sectioned and analyzed for cadmium, copper and zinc. Metal profiles for these sectioned cores will be presented to quantify metal deposition since the beginning of smelter operations in 1930.

Analyses of blood from two fish species northern pike and white sucker, for concentrations of cells and electrolytes (sodium, potassium, calcium, glucose, and osmolality) indicate that osmoregulatory failure is not being produced by these metal loadings. Preliminary analyses of liver from these fish indicate that low-molecular-weight metal-binding proteins (metallothioneins) are increased in metal-exposed fish. These proteins are correlated with increased tolerance to metal toxicity, and may serve to protect these fish from adverse effects produced by the metals. Several radiotracer displacement methods of rapid analyses of these proteins were evaluated and modified to use on aquatic biota. Using the modified method, metallothioneins were analyzed in fish liver and kidney, crayfish hepatopacreas, and whole zooplankton to determine their sensitivity and applicability as biological indicators of metal exposure. Results from these studies were presented at four national or international conferences during 1988. Three manuscripts are in preparation and will be submitted for publication prior to the end of 1989. This work was funded equally by LRTAP and the World Wildlife Foundation.

Report: Reports and information are available from: Freshwater Institute, Fisheries, Winnipeg, Manitoba.

Experimental Lakes Area (ELA)
Northwest Ontario

In Lake 223, experimentally acidified since 1976, direct toxicity effects of hydrogen ion and food chain effects on the biota had been observed at relatively high pH values (5.5-6.0) and many species were lost from the food chain. During 1989, a partial recovery phase was continued for the sixth consecutive year, with the mean epilimnetic pH controlled near 5.8. Some of these species lost during acidification have returned, and lake trout reproduction has resumed. Recovery of certain other species has not yet been observed. A target of pH 6.1 is planned for 1990.

In Lake 302, a double basin acidification study has been underway since 1982. The pH of the south basin, receiving additions of sulphuric acid, was held at 4.5 again during 1989, and food chain observations are continuing. As in Lake 223, a number of species have been lost, and some new species have appeared. Almost all fish have now disappeared from the basin while some insect species have proliferated. Another year of pH 4.5 is planned for 1990. For a third year, the pH of the north basin was held at approximately 5.4, using hydrochloric acid, to continue the study of effects of lowered pH on the bacterial communities controlling the nitrogen cycle.

A whole lake cadmium experiment continued on Lake 382 during 1989. This involved additions of both radiotracer and "cold" cadmium to delineate ecological pathways and physiological effects. The cadmium concentration averaged approximately 110 ng/L, still well below the current "safe standard" for protection of aquatic organisms. The experiment will continue in 1990 with a target concentration of cadmium of 150 ng/L.

A wetland acidification experiment, underway since 1983, continued on the Lake 239 bog. Effects on outflow chemistry are being monitored, and the direct effects on flora and insect fauna are under observation.

Hydrological and chemical monitoring continued on a small terrestrial watershed in preparation for a possible acidification study. Weirs have been installed to subdivide the watershed and permit closer evaluation of flows and chemical mass balances.

An experiment continued in Lake 260 to study the effects of organic toxicants (toxaphene, chlordane and dibenzofuran) on survival, growth, and gamete production of lake trout and white suckers. Selected fish were injected with the chemicals, then released in the lake, their natural habitat, pending later recapture and testing. Another study involving dibenzofurans, utilizing mesocosm-scale enclosures, was carried out in preparation for a proposed whole ecosystem organic containment study. Both these projects are expected to continue in 1990.

The Experimental Lakes Area has designated five lakes (111, 224, 239, 305, and 373) for inclusion in the DFO LRTAP lake monitoring program, which should continue for 15 to 20 years. Water chemistry and selected biota were monitored again in 1989 using standardized methods. Comparisons will be made with lakes in other regions.

Report: Reports and information are available from: Freshwater Institute, Winnipeg, Manitoba.

Effects of Short Term and Pulse Acidification on Ionoregulation in Juvenile Pacific Salmon

Yearling coho of two distinct stocks were exposed to short-term experimental conditions of constant low pH; and stepwise pH reduction to simulate, in part, stream conditions during episodic rainfall events. Blood samples of exposed fish were analyzed for osmolality, glucose, protein and selected ion concentrations to assess the extent of sub-lethal stress response elicited.

Report: Information may be obtained from: Habitat Management Division, Pacific Region, Fisheries and Oceans Canada, Vancouver, British Columbia.

7.4 SOILS AND GEOLOGY

No activities.

7.5 VEGETATION

Acid Rain National Early Warning System (ARNEWS)

The Acid Rain National Early Warning System was established to clearly and accurately detect signs of acid rain damage to forests. A nation-wide network of permanent plots has been established by Forestry Canada to detect and monitor changes in forest soil, vegetation, and trees.

The objective of the program is to obtain baseline data on the concentrations of foliar and soil elements, foliar and tree condition (including insect and disease levels), and tree growth. The baseline studies are to be followed by detection and monitoring of possible changes over a planned 20 to 25 year period.

A national establishment report (Information Report PI-X-91) providing a description of the system and each of the 103 plots was published in 1989, while a detailed methodology (Information Report DPC-X-25) was published in 1988. A report "The Canadian Forestry Service Air Pollution Program and Bibliography" (1988) by P. A. Addison and P. J. Rennie (Information Report DPC-X-26) is also available.

Detailed soil and foliar chemical analyses and mensurational data have been collected for all 15 of the ARNEWS plots established within British Columbia. While some tree mortality has occurred in nine of the 15 plots, it has been attributed to root rots, storm breakage and natural suppression of understorey trees. Visible symptoms of acid rain damage have not been detected to date. Yearly monitoring of vegetation condition is continuing, and all plots will be re-measured in 1990. Foliar and soils chemistry repeated for comparison with the baseline data obtained when the plots were established, starting in 1984.

Report: Reports are available from Forestry Canada, Victoria, British Columbia.

Biomonitoring Studies on Selected ARNEWS Plots

Thirty-four subplots were established in British Columbia ARNEWS sites. Presence, health, and percent cover of terrestrial mosses, lichens and liverworts were recorded. Six permanent arboreal subplots were established and pollution sensitive lichens transplanted. Initial results showed no visible damage to any of the plants. A re-assessment of the lichen transplants during 1988 suggests sulphur and lead level may be higher in three plots, but sample size was insufficient for statistical analysis. Additional samples were obtained during the fall of 1989 and more lichens transplanted to establish a larger data baseline. Visual and chemical analysis will be repeated after the growing season and a report prepared.

Report: Information is available from Forestry Canada, Victoria, British Columbia.

Search for Chemical Stress Indicators in Conifers

A study at Alice Arm, British Columbia is being conducted to determine the effects of chemical pollutants on conifers by examining tree foliage chemicals. The study is looking for stress indicator substances.

The amount and effect of deposition of airborne sulphur pollutants from the Alice Arm pulp mill on the foliar chemistry of Douglas-fir and Western hemlock conifers is being examined. Analyses were conducted using techniques developed at the Pacific Forestry Centre (PFC) for determining the terpene composition of small samples by mixed solvent extraction and dual column chromatographic identification of isolated components. To date sulphur (Total) and inorganic sulphur contents have been determined. The results indicate that western hemlock is much better able to cope with high sulphur exposures as total sulphur values exceeding 1% of the foliar dry weight have been found. In contrast, at sulphur contents much above 0.3% sulphur, Douglas-fir trees are obviously severely stressed. These results are being incorporated into a manuscript.

A number of individual trees have been sampled and an extensive chemical analyses of the foliar chemicals is being undertaken. If obvious differences are noted for badly affected individual trees relative to obviously healthy individuals from the same region, an intensive sampling program will be conducted and appropriate analyses performed to determine at what levels of airborne pollutant deposition induced stress-caused chemical changes can be detected.

Report: Further information will be available from: Forestry Canada, Pacific Forestry Centre, Victoria, British Columbia

7.6 HEALTH

No activities.

8. JOINTLY MANAGED ACTIVITIES

8.1 EMISSIONS AND CONTROL TECHNOLOGY

Vancouver Oxidants Study: Control Technology Options and Costs For Volatile Organic Compound Emissions From Gasoline Marketing

The Ministry of Environment and Environment Canada, in cooperation with the Greater Vancouver Regional District, Ministry of Energy, Mines and Petroleum Resources and the petroleum industry, hired services of a consultant and completed the study. The study investigated the control technology options and costs for reduction of volatile organic compound emissions from the gasoline marketing sector in the Greater Vancouver area. It also addressed the potential impacts of the reduction of gasoline vapour pressure on the emissions in the area.

Report: The information is available from the Ministry of Environment, Waste Management Branch, Victoria, British Columbia; and Environment Canada, West Vancouver, British Columbia.

8.2 AIR QUALITY AND DEPOSITION

The Role of Dust in Precipitation Chemistry

The western provinces and the Atmospheric Environment Service, Environment Canada, participated on a Task Group which is pursuing the question of dust and its impact on the precipitation chemistry in Western Canada.

A consultant's report has been produced and reviewed and is expected to be published in 1990.

Report: Information is available from: Alberta Environment, Edmonton, Alberta and Atmospheric Environment Service, Edmonton, Alberta

Chemistry of High Elevation Fog

The pilot study of fog and precipitation chemistry is now under way in Mt. Seymour park. Fog samples are being collected at two high-elevation sites. At the 760 metre level, a passive string collector is used and at the 990 metre level, co-located passive and active string collectors are used to collect samples. At the 860 metre level, weekly monitoring of precipitation is being carried out with an automatic collector.

The Pacific Region of the Atmospheric Environment Service is providing the synoptic and meteorological information related to fog chemistry sampling events. British Columbia has provided Mt. Seymour cloud chemistry results to Western Conifers Research Cooperative of the U.S. Environmental Protection Agency and a multi-authored publication is forth-coming.

Report: A report will be completed in 1990. Fog chemistry data are available from Environmental Protection Division, Ministry of Environment, Victoria, British Columbia.

8.3 SURFACE WATERS

No activities.

8.4 SOIL AND GEOLOGY

No activities.

8.5 VEGETATION

No activities.

8.6 HEALTH

No activities.

9.1 BRITISH COLUMBIA

Greater Vancouver Regional District (GVRD) Air Management Plan

The GVRD is developing a comprehensive air quality management plan to describe present and future air quality issues, and control options to ensure good air quality in the future. The first stage of the plan was completed in September 1989 and a report was published. Stage 2 of the plan will describe options for the control of current and future air quality problems. Among these, transportation planning is likely to be important in influencing future air quality, since approximately 80% of the emissions in the region are from mobile sources.

Report: Information is available from: Greater Vancouver Regional District, Pollution Control Department, Burnaby, British Columbia.

9.2 ALBERTA

Measurement of Methane and Carbon Dioxide Flux from Ontario and Alberta Wetlands

Methane in the atmosphere has increased in recent decades and the causes are poorly understood. The purpose of this project is to investigate the factors controlling gaseous carbon flux from wetland vegetation, wetland pools and a beaver pond. The spatial and temporal variability of CH_4 and CO_2 emissions from the wetlands will be measured. This variation will then be related to temperature hydrology and acid deposition.

The possibility that sulphate deposition from acid rain inhibits methane emissions will continue to be investigated. Preliminary data suggest that this occurred in 1988 and 1989.

Seasonal methane measurements in the fens of northern Alberta will also be made. Moderately-rich and rich fens are expected to generate high fluxes of CH_4 to the atmosphere because the water level remains near the surface of the peat for most of the year. Wetlands in northern Alberta comprise a large part of the boreal forest ecosystem, and may be a significant source of CH_4 to the atmosphere.

Report: Further information is available from: Dr. S. Bayley, Department of Botany, University of Alberta, Edmonton, Alberta.

Experimental Acidification of a Whole Wetland Ecosystem

This study will determine the effects of simulated acidic deposition on a 3.5 ha oligotrophic wetland that has been experimentally acidified for 5 1/2 years. Effects on ecosystem components - water chemistry, vegetation, amphibian, and insect fauna - will be assessed in an acidified portion of the mire (2.66 ha) and in an unacidified control (0.85 ha) portion that receives only lake water.

The water chemistry of the wetland pools has just started to change after five years of acidification. It is proposed that these changes will be documented. The initially high plant production values have gradually decreased in the last three years. Control and experimental productivity was equal in 1988. It is proposed to determine whether production rates will continue to decline. Peat accumulation rates will also be documented. The effect of acid deposition on the ability of Sphagnum to retain and neutralize acid anions will be assessed, including changes in the base cation exchange capacity of the wetland. Experiments to assess the ability of amphibians to tolerate acid deposition will be made in experimental and control areas of the wetland.

Report: Further information is available from: Dr. D. Vitt and Dr. S. Bayley, Department of Botany, University of Alberta, Edmonton, Alberta.

Studies of Biological Communities and Biochemical Cycles in Natural and Anthropogenically-modified Lakes in the Canadian Rocky Mountains

A broadly-based program is being developed to study linkages between watersheds, airsheds and lakes, and between aquatic communities and biogeochemical cycles. The studies will address how ecosystems respond to man-made stresses such as eutrophication, acidification, radionuclide and trace metal addition, and alterations in the catchment.

The hypothesis that long range transport by the atmosphere has delivered a variety of chemical pollutants to the Rockies but not in high enough concentrations to have affected ecosystems, will be tested. Instead of heavy reliance on whole-lake experimentation, this study will emphasize re-surveys of lakes with early records, paleoecological analyses and comparative studies of lakes with different communities.

Report: Further information is available from: Dr. D. W. Schindler, Department of Zoology/Botany, University of Alberta, Edmonton, Alberta.

The LNS Burner Heavy Oil Recovery Demonstration Project

The Low NO_x/SO_x (LNS) Burner is a technology which, in pilot scale tests, significantly reduces acid rain-forming emissions from the burning of coal. The implications for Canada and Alberta are significant if the technology proves adaptable on a commercial scale for utility and industrial applications.

The project which Esso and TransAlta are undertaking will demonstrate how coal can be burned cleanly for steam raising in heavy oil operations by using TransAlta's LNS Burner on a steam generator at Esso's Cold Lake Production Project. The project is expected to take two years to complete.

This technology is expected to meet the needs of industry and utilities to reduce acid emissions, at a dramatically lower cost than any emission control initiatives currently being contemplated. The LNS Burner will be applicable for installation in new and "retrofit" situations for both enhanced oil recovery facilities and electric power plants.

Report: Further information is available from: W. L. Fraser, TransAlta Resources Investment Corporation, Calgary, Alberta.
J. P. Aiello or D. G. Schulz, Esso Resources, Calgary, Alberta.

9.3 SASKATCHEWAN

Saskatchewan Power Corporation Monitoring Activities at Poplar River (Coronach) and Boundary Dam (Estevan) Power Stations

One station continuously monitoring ground level concentrations of sulphur dioxide is located at the Canada/U.S. International Boundary southeast of the Poplar River Power Station. Emissions at the Poplar River Power Station are continuously monitored for opacity, sulphur dioxide, and nitrogen oxides concentrations. Surface waters in the vicinity of the Poplar River, Boundary Dam, Queen Elizabeth, and Estevan power stations are monitored and analyzed for pH, sulphates, nitrates, alkalinity, and other ions. Surface water data were also collected at the Nipawin Hydroelectric Station.

Report: Further information is available from the Saskatchewan Power Corporation and Saskatchewan Environment and Public Safety, Regina, Sask.

Saskatchewan Power Corporation - SO_2 Emission Reduction.

In 1989 SaskPower and Tampella began detailed engineering for a demonstration SO_2 control system (LIFAC). The LIFAC system, which is to be installed at the Poplar River Power Station, will enable SaskPower to conduct a detailed performance and reliability evaluation of this technology for possible installation on Shand Unit 1.

Report: Information available from the Director, Materials Research, Research and Development Centre, Saskatchewan Power Corporation, Regina, Sask.

Saskatchewan Power Corporation - Emission Survey

SaskPower has initiated a survey of NO_x and SO_2 emissions at its thermal power stations. The survey will cover at least a 24-hour period at each station with more extensive monitoring at the Boundary Dam Power Station.

Report: Further information is available from the Saskatchewan Power Corporation and Saskatchewan Environment and Public Safety, Regina, Sask.

Saskatchewan Power Corporation - Development of improved Reagents for SO_2 Capture in Dry Injection Systems.

Laboratory tests and experimentation are continuing on development of improved calcium-based reagents for abatement of sulphur dioxide emissions. Potentially cost-effective methods of achieving finer calcium hydroxide sorbents have been identified in the work done previous to this year. Whether these improvements in sorbent particle size translate into greater reactivity of SO_2 will be determined in future work, including completion of, and studies with, a bench scale reactor. The reactor is designed to simulate furnace conditions expected at the Shand plant presently being built. This reactor will also be used to study the sorbent characteristics of limestone to be used on the LIFAC system at the Poplar River and Shand power stations.

Report: Information available from Director, Materials Research, Research and Development Centre, Saskatchewan Power Corporation, Regina, Sask.

Saskatchewan Power Corporation Disposal Procedures of Ashes Recovered From Power Plants Where Dry Sorbent Injection Has been Used to Control SO_2 Emissions

Synthetic ashes consisting of power plant fly ash and additions of lime and calcium sulphate have been prepared to simulate ashes expected from future power plant where dry sorbent injection technology will be used to control SO_2 emissions. These ashes have been studied for leaching characteristics, heat evolution upon water contact, permeability, swelling and setting. The clays surrounding the ash disposal site have been studied for their capacity to retain ash leachate. In addition, preliminary studies have been carried out on the setting and permeability properties of these ashes when mixed with bentonite. Utilization options for these ashes are also being examined. Work is in progress.

Report: Information available from Director, Materials Research, Research and Development Centre, Saskatchewan Power Corporation, Regina, Sask.

Saskatchewan Power Corporation Environmental Studies.

Methods are researched for identification and monitoring of toxic emissions from power plants. Special techniques and a quality assurance program were developed for identification analysis of PCB compounds.

Report: Information available from Director, Materials Research, Research and Development Centre, Saskatchewan Power Corporation, Regina, Sask.

Monitoring at AMOK Ltd. Uranium Mine, Cluff Lake.

The average sulphation levels are determined on monthly basis at 23 sites around the mine using lead peroxide plates.

Report: Data summaries are available from Amok Ltd., Saskatoon, Sask. and Saskatchewan Environment and Public Safety, Regina, Sask.

Monitoring at Eldor Mines Uranium Mine, Rabbit Lake.

Eldor Mines continuously monitors ground level concentration of sulphur dioxide at one site.

Report: Data summaries to be available from Eldor Mines, Saskatoon, Sask. and Saskatchewan Environment and Public Safety, Regina, Sask.

9.4 MANITOBA

Damage to Plants as a Result of Environmental Stresses

Damage to plants as a consequence of physical and chemical environmental stresses, continued to be investigated by the Botany Department of the University of Brandon during 1989. Tree decline continued and has been recorded throughout much of southern Manitoba and southern Saskatchewan.

The review of the available data, on the measured levels of nitrous oxides, sulphur dioxide and ozone in various parts of the province over the past 18 years, indicates that the annual production level of these gases in the region of concern is significantly below those reported to cause tree decline elsewhere. Preliminary assessment of precipitation samples from Brandon and several rural locations indicates alkaline pH values. Therefore, the leaching of nutrients by acidic precipitation does not appear to explain the leaf and needle nutrient deficiency symptoms.

Similarities have been noted between some of the symptoms on several species and observations from accidental and deliberate exposure of these same species to phenoxyacetic acid type herbicides (MCPA, 2, 4-D, etc.).

Report: Further information is available from the University of Brandon, Brandon, Manitoba.

Monitoring in Flin Flon

Four stations continuously monitored ground level concentrations of sulphur dioxide within five kilometres of the 250 metre high main stack of the non-ferrous smelter facility. The stations were operated by Hudson Bay Mining and Smelting.

Report: Data summaries are available through Hudson Bay Mining and Smelting Company Ltd., Flin Flon, Manitoba.

Removal of Sulphur - Hudson Bay Mining and Smelting

Studies to research and develop process technology to reduce emissions from the zinc and copper producing operations of Hudson Bay Mining and Smelting Company at Flin Flon continued during 1989.

Report: These programs are ongoing. Further information is available through Hudson Bay Mining and Smelting Company Ltd., Flin Flon, Manitoba.

Monitoring in Thompson

A permanent station continued monitoring ground level concentrations of sulphur dioxide in 1989. The station is located northwest of the Inco non-ferrous smelter facility between the plant and the Town of Thompson. A mobile station was in operation during the spring, summer, and early fall (the growing season) to monitor sulphur dioxide concentrations from other directions. A telemetry system improves the ability to obtain data. There is a meteorological program to regulate the smelter production in such a way that acceptable concentrations of sulphur dioxide in the Thompson airshed are maintained under different dispersion conditions.

Satellite imagery used to detect and map vegetation changes in the Thompson area continued. Maps for 1973, 1978 and 1983 have been produced and the ones for 1988 are in preparation.

Report: Data summaries are available from Inco Limited, Thompson, Manitoba.

Removal of Sulphur - Inco

The research program conducted by Inco Ltd., Manitoba Division, on the reduction of sulphur in the concentrate being smelted continued in 1989.

Report: This is an ongoing program. Further information is available from Inco Limited, Thompson, Manitoba.

10. ADDRESSES FOR FURTHER INFORMATION

BRITISH COLUMBIA

Ministry of Environment
Parliament Buildings
Victoria, British Columbia
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Greater Vancouver Regional District
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ALBERTA

Alberta Environment
Corporate and Strategic
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Main Floor, Oxbridge Place
9820 - 106 Street
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Alberta Environment
Soil Protection Branch
Wastes and Chemicals Division
P.O. Box 3014
Cousins Building
Lethbridge, Alberta
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Alberta Environmental Centre
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Vegreville, Alberta
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University of Alberta
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TransAlta Resources Investment Corporation
Box 1900
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Esso Resources Canada Limited
237 - 4 Avenue S.W.
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University of Saskatchewan
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Saskatchewan Environment and
Public Safety
Walter Scott Building
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Regina, Saskatchewan
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Saskatchewan Power Corporation
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Saskatchewan Research Council
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NORTHWEST TERRITORIES

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Renewable Resources
Government of the Northwest Territories
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Wildlife Service
Renewable Resources
Government of Northwest Territories
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FEDERAL AGENCIES

BRITISH COLUMBIA (FEDERAL)

Environmental Protection
Pacific and Yukon Region
Conservation and Protection
Environment Canada
224 West Esplanade
North Vancouver, British Columbia
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Fisheries and Oceans Canada
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555 West Hastings
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Scientific Services Division
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Atmospheric Environment Service
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Institute of Ocean Sciences
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Forestry Canada
Pacific Forestry Centre
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ALBERTA (FEDERAL)

Canadian Wildlife Service
Environment Canada
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Environment Protection
Western and Northern Region
Conservation and Protection
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Forestry Canada
Northern Forestry Centre
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Scientific Services Division
Western Region
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Superintendent
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SASKATCHEWAN (FEDERAL)

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Western and Northern Region
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1st Floor, Motherwell Building
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Scientific Services Division
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Atmospheric Environment Service
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NORTHWEST TERRITORIES (FEDERAL)

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Environmental Services Branch
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Health and Welfare Canada
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Ottawa, Ontario
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11. GLOSSARY OF ACRONYMS AND ABBREVIATIONS

ADRP	- Acid Deposition Research Programme (Alberta)
AES	- Atmospheric Environment Service
ARNEWS	- Acid Rain National Early Warning System
CAPMoN	- Canadian Air and Pollution Monitoring Network
CH_4	- methane
CO_2	- carbon dioxide
CPANS-APCA	- Canadian Prairie And Northern Section - Air Pollution Control Association
DDT	- DichloroDiphenyl Trichloroethane
DFO	- Department of Fisheries and Oceans
DIAND	- Department of Indian Affairs and Northern Development
EC	- Environment Canada
ELA	- Experimental Lakes Area
EP	- Environmental Protection
GNWT	- Government of the North West Territories
GVRD	- Greater Vancouver Regional District
ha	- hectare
H_2S	- hydrogen sulphide
K_2CO_3	- potassium carbonate
kg SO_4/ha/yr	- kilograms sulphate per hectare per year
kg/ha/yr	- kilograms per hectare per year
km	- kilometre
L	- litre
LNS	- Low NO_x/SO_x
LRTAP	- Long Range Transport of Air Pollutants
m^2	- square metres
m^3	- cubic metres
mg m^{-3}	- milligrams per cubic metre
g/m^3	- micrograms per cubic metre
ng/L	- nanograms per litre
NO_x	- nitrogen oxides
NWT	- NorthWest Territories

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

PAH	- PolyAromatic Hydrocarbon
PbO_2	- lead dioxide
PCB	- PolyChlorinated Biphenyl
PFC	- Pacific Forestry Centre
ppm	- parts per million
SAQ	- Saqvaqjuac
SCUBA	- Self-Contained Underwater Breathing Apparatus
SO_x	- sulphur oxides
TEA	- triethanol amine
USSR	- Union of Soviet Socialist Republics
WNCLTC	- Western and Northern Canada Long Range Transport of Air Pollutants Technical Committee